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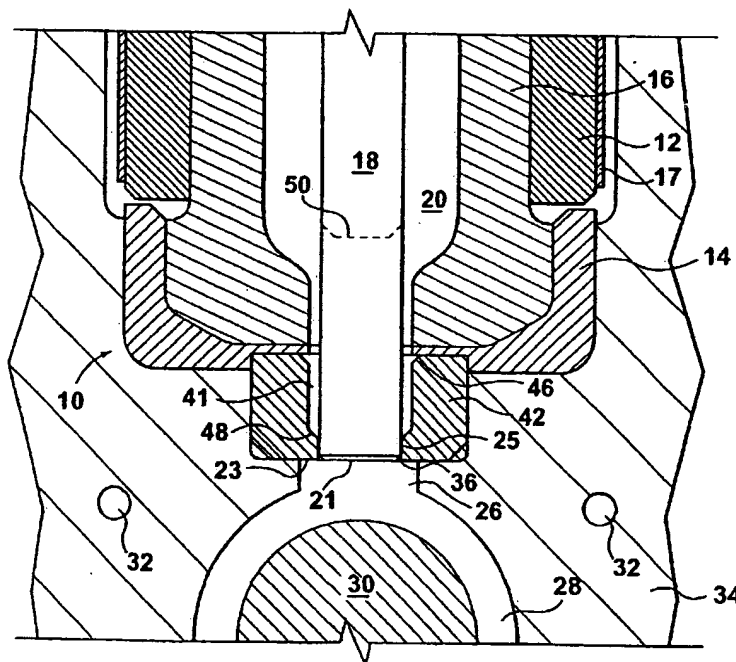
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[Continued on next page]

(54) Title: **METHOD AND APPARATUS FOR INJECTION MOLDING ARTICLES**



(57) Abstract: An injection molding system having an improved valve gate arrangement that provides molded articles with improved vestige and or surface quality.

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*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

METHOD AND APPARATUS FOR INJECTION MOLDING ARTICLESTECHNICAL FIELD

5 This invention relates to injection molding systems. More specifically, the present invention relates to a valve gating system found in injection molding systems.

BACKGROUND OF THE INVENTION

10

Injection molding nozzles are well known and are used to inject materials, such as plastic, into the cavity of a mold. For example, such nozzles receive molten material, such as plastic, from an injection molding machine and direct the same into a mold cavity through a passage called a gate. When an injection operation is complete, and prior to opening the mold cavity to eject the molded part, the transfer of molten material through the gate must be stopped. Generally, two methods exist for stopping the transfer of molten material through the gate, namely: thermal, or open, gating; and valve gating.

In thermal gating, the gate is an open aperture through which molten material passes during an injection operation. The gate is rapidly cooled at the end of the injection portion of the cycle, when the injection pressure is removed, to "freeze" the injected material into a plug. This plug remains in the gate to prevent drool of molten material from the gate when the mold is open for the ejection of the molded part. In the next injection portion of the cycle, the cooling applied to the gate is removed and hot molten material from the injection molding machine pushes the plug into the mold cavity, where it melts and mixes with the newly provided molten material.

35 In valve gating, the opening and closing of the gate is independent of injection pressure and/or cooling and is achieved mechanically with a valve stem. This stem can be moved between an open position, wherein flow of molten materials through the gate is permitted, and a closed position wherein the gate is closed by entry of the valve stem into the

gate which establishes a seal, preventing molten materials from passing through the gate. Valve gating is well known and examples of such systems are shown in U.S. Pat. Nos. 2,878,515; 3,023,458; and 3,530,539, each being incorporated  
5 herein by reference.

Generally, for situations that require improved aesthetics, valve gating is preferable to thermal gating because it can reduce the undesired gate vestige which results on the  
10 finished molded part. However, there are problems with valve gating systems.

Specifically, the valve stem and gate each have a complementary sealing portion which are brought into contact  
15 to seal the gate. Typically there is a .001"-.002" diametrical clearance between the valve stem and the gate sealing portion. As the valve stem is moved into alignment with the sealing portion of the gate to effect sealing, a slight misalignment of the stem with the gate will cause the  
20 stem to strike the gate sealing portion. Over time, this will cause the gate area to wear and become misshapen. Now that the gate sealing area is worn, the stem no longer stops the flow of molten material and a small amount of molten material will migrate between the stem and the worn gate sealing area.  
25 This leakage adversely impacts the vestige quality because as the mold is opened, the now solidified material between the gate and the valve stem will cause a tear or blemish to form along the vestige of the part, and in extreme cases, the tearing can propagate to the surface of the molded article or  
30 preform.

Following the injection cycle, typically the mold halves will open and the molded article in a somewhat solidified state will be removed from the area of the stem/gate area. Due to  
35 the entrapped molten material between the worn gate area and the stem, the molded article will not break away cleanly when the mold is opened, but rather will tear away from the gate area, which results in a blemished vestige on the molded article.

Referring to FIG. 1 and 2 this phenomenon can be clearly seen.

As well known in the art, a nozzle assembly 10 is comprised of an elongated nozzle bushing 12 with a nozzle tip 16 affixed co-axially therein. Optionally, an insulator 14 is affixed to a proximal end of the nozzle tip 16 thereby thermally insulating the heated nozzle assembly 10 from the cooled cavity plate 34. A movable valve member 18 extends co-axially in the nozzle assembly 10 and is selectably positioned in or out of a passageway/gate area 22. A melt channel 20 surrounds the valve member 18 and runs the length of the nozzle assembly 10 to communicate a flowable material to a mold cavity 28. When the valve member 18 is placed in a fully closed position (as shown in FIG. 1), a sealing portion 25 in the cavity plate 34 sealingly surrounds the valve member 18 to shut off the flow of material to the mold cavity 28. As shown in FIG. 1, a face portion 21 of valve member 18 defines the entire top of the vestige 26 of the molded article. A chamfer 36 is typically provided along the face of the valve member 18 to help guide the valve member into the gate area and reduce wear of the valve member and cavity plate 34.

Due to the close fit of the valve member 18 to the sealing portion 25, any misalignment that exists between their respective interfaces will cause the valve member 18 to strike the surface of the sealing portion 25 which will ultimately lead to a deterioration of the seal portion 25 and/or the valve member 18.

At the end of the injection cycle, the valve member 18 is moved into its closed position as previously described and the mold cavity is held in a closed position with a core 30 for a predetermined cycle time to allow the molten material to cool and solidify, thereby forming the molded article. Once the molded article has been allowed to cool to a sufficient level, the core 30 with the molded article thereon is moved in the direction as denoted by arrow A, and the vestige 26 is pulled away from the face portion 21 of the valve member 18. If enough wear exists between the valve member 18 and the sealing portion 25, a small amount of molten material will migrate therein, and as the mold core 30 and the molded article 27 are

moved to an open position, a peeled edge 38 will form on the vestige 26 of the molded article 27.

Also, as the valve member 18 is in the flow of molten material when the gate is open, it can become quite hot. When the gate is closed by the valve member 18, the hot tip of the valve member 18 can be difficult to cool as the mold cavity 28 is cooled and this can result in a need for increased cycle times to permit the necessary cooling, and/or can result in undesirable characteristics in the molded article 27. Specifically, as the material in the mold cavity 28 adjacent the valve member 18 is cooled less efficiently due to the hot tip, parts molded from thermally sensitive materials such as PET can suffer from an enlarged area of crystallinity 40 or other undesired characteristics. In addition, since the entire top surface of the vestige 26 is in contact with the face portion 21 of the hot valve member 18, the molten material adjacent the face portion 21 remains somewhat molten and stringing and an uneven edge forms when the mold is opened.

Therefore there is a need for an improved injection-molding machine with a valve gate system that reduces or obviates some or all of the drawbacks of the prior art.

#### SUMMARY OF THE INVENTION

The primary objective of the present invention is to provide an improved injection molding system with a valve gating system that reduces or obviates the drawbacks of the prior art.

Another object of the present invention is to provide an insert that interfaces with a valve member in an injection molding system that reduces or eliminates the formation of peeled edges along a vestige of a molded article.

Yet another object of the present invention is to provide a gate insert in the mold plate adjacent the valve member that may be easily replaced.

The foregoing objects are achieved by providing a mold cavity with a vestige cross-sectional area that is larger than the cross-sectional area of the valve member so that the periphery of the vestige is cooled quicker than the interior portion of the vestige. In another preferred embodiment, a replaceable insert is provided to help guide the valve member into a sealing position with the gate. Replacement of this insert can easily be performed whenever the wear of the insert reaches a predetermined and unacceptable level.

Further objections and advantages of the present

#### BRIEF DESCRIPTION OF THE DRAWINGS

- FIG. 1 is a simplified cross-sectional view of an injection molding nozzle in accordance with the prior art;
- FIG. 2 is a partial cross-sectional view of a molded article in accordance with the prior art;
- FIG. 3 and 3a are simplified cross-sectional views of exemplificative embodiments in accordance with the present invention;
- FIG. 4a and 4b are partial cross-sectional views of alternate exemplificative embodiments in accordance with the present invention;
- FIG. 5 is a simplified partial cross-sectional view of a molded article.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

- Referring now to FIG. 3, an injection molding nozzle assembly 10 in accordance with the present invention is located in a cavity plate 34 for the communication of a flowable material to a mold cavity 28 for the formation of a molded article therein. Cavity plate 34 is provided with a plurality of cooling passageways 32 therein for the communication of a

cooling fluid for the removal of heat from the cavity plate to cool and solidify the flowable material in the mold cavity 28.

The nozzle assembly 10, as well known in the art, is comprised of an elongated nozzle bushing 12 with a nozzle tip 16 affixed to a proximal end of the nozzle bushing. In a preferred embodiment, the nozzle tip 16 is threaded to the nozzle bushing 12, but any such suitable means could be used. Typically, a heater 17 is wrapped around the nozzle assembly 10 to maintain the flowable material in a viscous state. In the preferred embodiment an optional insulator 14 is located between the nozzle tip 16 and the cooled cavity plate 34 to reduce the transfer of heat from the hot nozzle tip 16 to the cooled cavity plate 34. Located co-axially in the nozzle assembly 10 is a movable valve member 18 that extends adjacent a vestige 26 of the mold cavity 28. In a preferred embodiment, the valve member 18 is a slender elongated cylindrical piece that is moved up and down to an open and closed position respectively. When the valve member 18 is in the open position as shown by phantom line 50, the flowable material in melt channel 20 is allowed to enter the mold cavity 28. When placed in the closed position, as shown in FIG. 1, the valve member 18 is in sealing communication with a sealing portion 25 thereby stopping the flow of material to the mold cavity 28.

In one preferred embodiment, an insert 42 with a passageway 41 formed therein is placed in a cavity 44 located in the cavity plate 34 in alignment with the valve member 18. In this arrangement, the sealing portion 25 is located in this replaceable insert 42 to allow for easy maintenance when leakage around the valve member 18 starts to occur.

The insert 42 may optionally provide a first chamfer 46 to help guide the valve member 18 when it first enters the passageway 41 and a second chamfer 48 to help guide the valve member further into the sealing portion 25. These chamfers act to reduce wear on both the valve member 18 and the insert 42 and prolong the useable life of both components.



Vestige 26, as shown in the figures, has a cross-sectional area larger than the face portion 21 of the valve member 18. As such, a portion 23 of the vestige 26 is in thermal communication with the insert 42. Given that the insert 42 is placed in the cooled cavity plate 34, the insert 42 will cool portion 23 faster than the portion in contact with face portion 21 of the hot valve member 18. This differential cooling action will allow portion 23 to solidify before the area adjacent face portion 21. When core 30 is retracted to remove the molded article from the mold cavity 28, this now solidified portion 23 will tend to breakaway more cleanly than the prior art. In addition, due to the location of the sealing portion 25 being internal and displaced from the outer surface of the finished vestige 26, any tearing that may occur when the mold is opened is reduced or eliminated because the tear is not on the surface of the vestige/preform as in the prior art.

As shown in FIG. 5, this clean break will result in a more uniform and flat vestige 26 than previously seen. In addition, a reduced area of crystallinity 40 will form inside the molded article 27 due to the improved cooling of the vestige 26.

Referring to FIG. 3A, an alternative embodiment in accordance with the present invention is shown which is identical to the embodiment in FIG. 3 except for the removal of the insert 42.

As shown in FIG. 3A, the sealing portion 25 is now located in the cavity plate 34. Cooling of portion 23 will still occur quicker than in the remainder of the vestige 26, which will allow for a substantially clean break when mold core 30 is retracted.

FIG. 4a and 4b (where like features have like numerals) show alternative embodiments of the insert 42 and the valve member 18. As shown in FIG. 4a, the valve member 18 has a chamfer 54 near the vestige 26. A reduced diameter section of the valve member is in sealing communication with the sealing portion 25 when in the closed position. At least one elongated recess 56 is formed in the surface of the valve member 18 which allows

the flowable material to be forced up along the valve member 18 as the valve member is brought to the closed position. Chamfers 46 and 48 help guide the valve member 18 as it enters the passageway 41 and seats in the sealing portion 25. FIG. 4b shows the valve member 18 as one continuous cylinder down to the chamfer at the very bottom. The passageway 41 in the insert 42 is also a uniform diameter for most of its length, except for the lead in chamfer 46. In this embodiment, the sealing portion 25 can be longer and provide a longer lasting seal. The recess 56 allows the flowable material to flow up out of passageway 41 as the valve member 18 is brought to a closed position.

It is to be understood that the invention is not limited to the illustrations described herein, which are deemed to illustrate the best modes of carrying out the invention, and which are susceptible to modification of form, size, arrangement of parts and details of operation. The invention is intended to encompass all such modifications, which are within its spirit and scope as defined by the claims.

## WHAT IS CLAIMED IS:

1. An apparatus for injection molding at least one article,  
said apparatus having at least one mold cavity and a  
supply of flowable material communicated to said mold  
cavity through at least one injection nozzle, comprising:

a movable valve member having a predetermined cross-  
sectional area to selectably start and stop the  
communication of said flowable material through a  
nozzle gate in each said nozzle, and;

a vestige adjacent said nozzle gate protruding from a  
surface of said article, wherein said vestige has a  
cross-sectional area greater than said cross-  
sectional area of said valve member.

2. The apparatus in accordance with claim 1 wherein said  
article is a preform.

3. The apparatus in accordance with claim 2 wherein said  
preform is made from PET.

4. The apparatus in accordance with claim 1 wherein said mold  
cavity is formed between a cavity plate and a mold core.

5. The apparatus in accordance with claim 4 wherein said mold  
core is selectably movable to an open and closed position.

6. The apparatus in accordance with claim 4 wherein said  
nozzle gate is located in said cavity plate.

7. The apparatus in accordance with claim 4 wherein said  
nozzle gate is located in an insert located in said cavity  
plate.

8. The apparatus in accordance with claim 7 wherein said  
insert is replaceable.

9. The apparatus in accordance with claim 1 wherein said

injection nozzle comprises:

5 an elongated nozzle bushing having a melt passageway therein, said nozzle bushing placed in a cavity of a cavity plate in alignment with said mold cavity,

10 a nozzle tip affixed to said nozzle bushing for the communication of a flowable material from said nozzle bushing to said mold cavity,

a heater in thermal communication with said injection nozzle.

15 10. The apparatus in accordance with claim 1 wherein said valve member is cylindrical.

20 11. The apparatus in accordance with claim 1 wherein said valve member has a reduced diameter portion in sealing communication with said nozzle gate.

25 12. The apparatus in accordance with claim 1 wherein said valve member has at least one longitudinal recess on the surface of said valve member to allow for the communication of said flowable material.

30 13. An apparatus for injection molding at least one article comprising:

35 a source of flowable material in fluid communication with at least one injection nozzle, said injection nozzle having an outlet in alignment with a mold cavity for the formation of said article therein;

40 a movable valve member for selectably starting and stopping the communication of said flowable material through said outlet;

said article having a vestige adjacent said valve member, wherein the cross-sectional area of said valve member is less than said vestige.

14. The apparatus in accordance with claim 13 wherein said article is a preform.

5 15. The apparatus in accordance with claim 14 wherein said preform is made from PET.

10 16. The apparatus in accordance with claim 13 wherein said mold cavity is formed between a cavity plate and a mold core.

15 17. The apparatus in accordance with claim 16 wherein said mold core is selectably movable to an open and closed position.

18. The apparatus in accordance with claim 16 wherein said nozzle gate is located in said cavity plate.

20 19. The apparatus in accordance with claim 16 wherein said nozzle gate is located in an insert located in said cavity plate.

25 20. The apparatus in accordance with claim 19 wherein said insert is replaceable.

21. The apparatus in accordance with claim 13 wherein said injection nozzle comprises:

30 an elongated nozzle bushing having a melt passageway therein, said nozzle bushing placed in a cavity of a cavity plate in alignment with said mold cavity,

35 a nozzle tip affixed to said nozzle bushing for the communication of a flowable material from said nozzle bushing to said mold cavity,

a heater in thermal communication with said injection nozzle.

40 22. The apparatus in accordance with claim 13 wherein said

valve member is cylindrical.

23. The apparatus in accordance with claim 13 wherein said valve member has a reduced diameter portion in sealing communication with said nozzle gate.

24. The apparatus in accordance with claim 13 wherein said valve member has at least one longitudinal recess on the surface of said valve member.

25. In an injection molding system, a manifold subsystem for the communication of a flowable material, comprising:

a manifold structure having at least one melt passageway in fluid communication with at least one injection nozzle;

a cavity plate in spaced-apart alignment with a mold core for the formation of a cavity therebetween, said nozzle being in fluid communication with said cavity through a nozzle gate for the formation of a molded article therein,

an insert having a passageway therethrough in fluid communication between said nozzle and said nozzle gate,

a movable valve member for selectably stopping and starting the communication of said flowable material to said cavity, and

said nozzle gate adjacent a vestige protruding from said molded article, wherein said vestige cross-sectional area adjacent said valve member is larger than the cross-sectional area of said valve member that contacts said molded article.

26. The apparatus in accordance with claim 25 wherein said molded article is a preform.

27. The apparatus in accordance with claim 26 wherein said preform is made from PET.

28. The apparatus in accordance with claim 25 wherein said mold core is selectably movable to an open and closed position.

29. The apparatus in accordance with claim 25 wherein said nozzle gate is located in said cavity plate.

30. The apparatus in accordance with claim 25 wherein said nozzle gate is located in an insert located in said cavity plate.

31. The apparatus in accordance with claim 30 wherein said insert is replaceable.

32. The apparatus in accordance with claim 25 wherein said injection nozzle comprises:

an elongated nozzle bushing having a melt passageway therein, said nozzle bushing placed in a cavity of a cavity plate in alignment with said mold cavity,

a nozzle tip affixed to said nozzle bushing for the communication of said flowable material from said nozzle bushing to said mold cavity,

a heater in thermal communication with said injection nozzle.

33. The apparatus in accordance with claim 25 wherein said valve member is cylindrical.

34. The apparatus in accordance with claim 25 wherein said valve member has a reduced diameter portion in sealing communication with said nozzle gate.

35. The apparatus in accordance with claim 25 wherein said valve member has at least one longitudinal recess on the

surface of said valve member to allow for the communication of said flowable material.

36. In an injection molding system for the formation of a molded article, a gate insert comprising:

a body having a passageway formed therein, said passageway located between an injection nozzle assembly and a mold cavity for the communication of a fluid to said mold cavity,

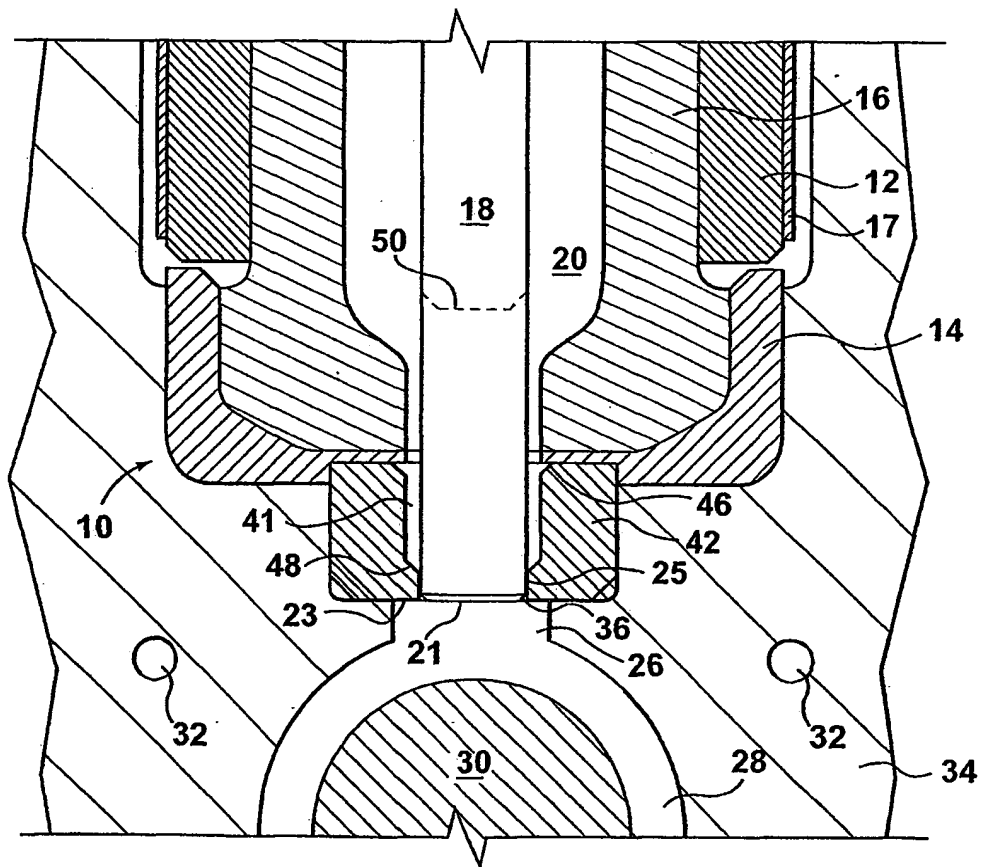
an orifice portion of said passageway in sealing communication with a movable valve member such that when said valve member is adjacent said orifice portion the flow of said fluid to said cavity is prevented,

a raised portion protruding from said molded article in thermal communication with said gate insert and said valve member thereby cooling the outer periphery of said raised portion faster than the interior of said raised portion.

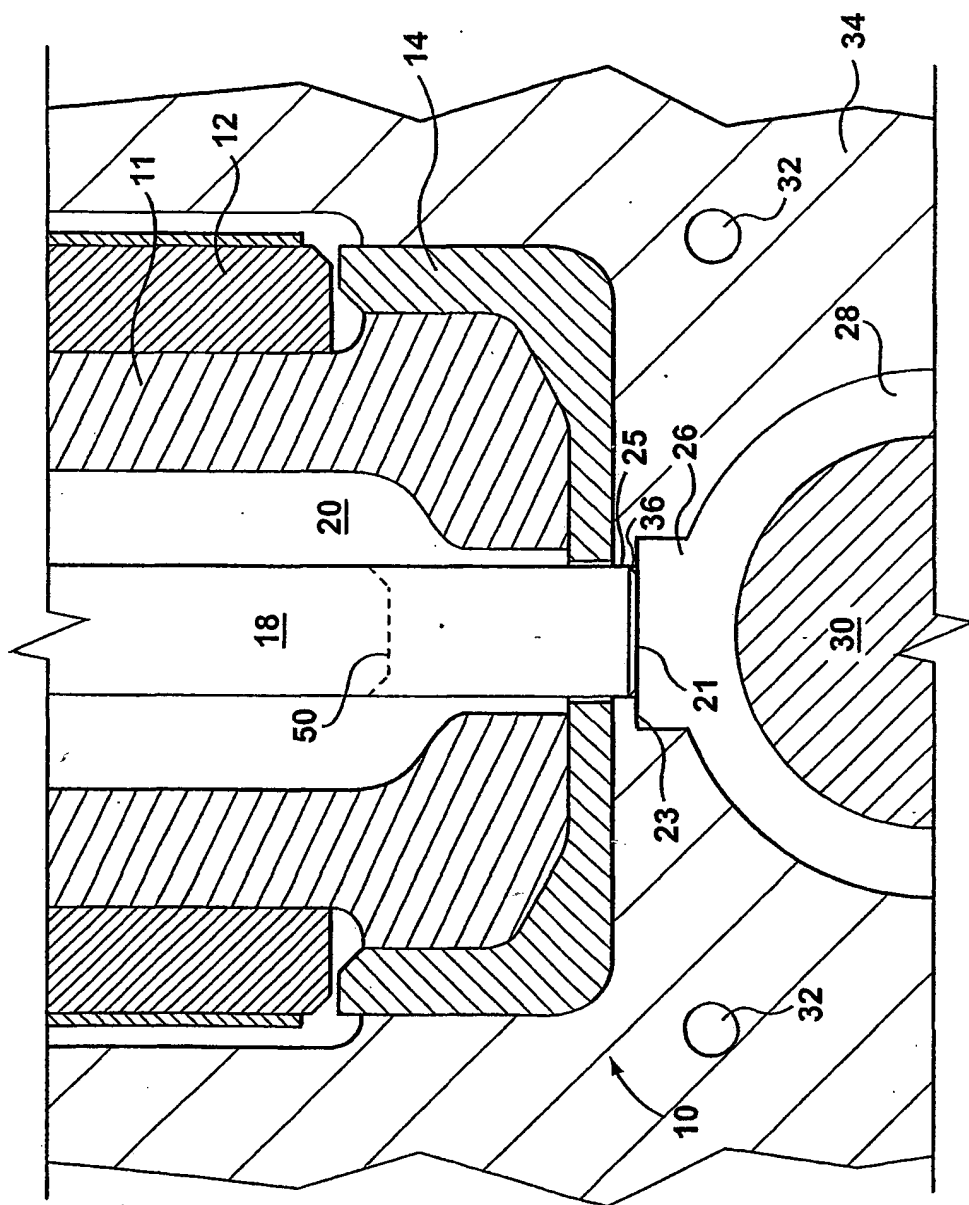




2 / 5

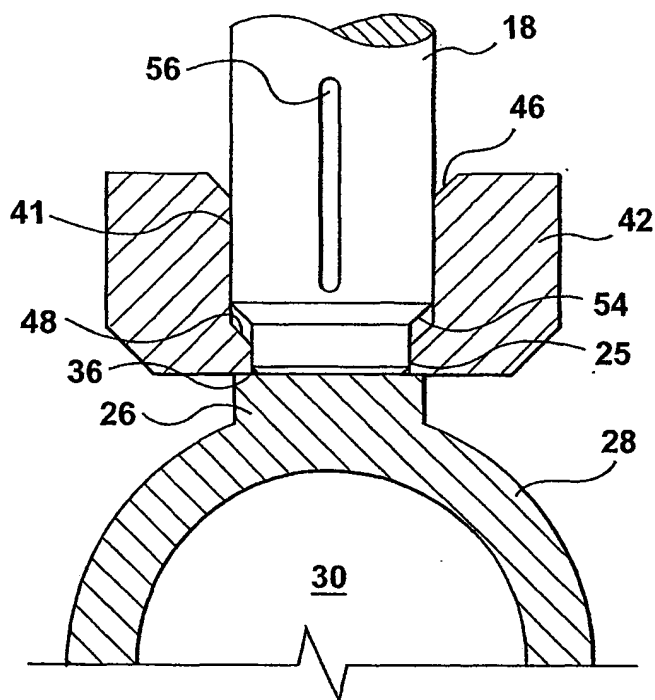
**FIG. 3**

3 / 5

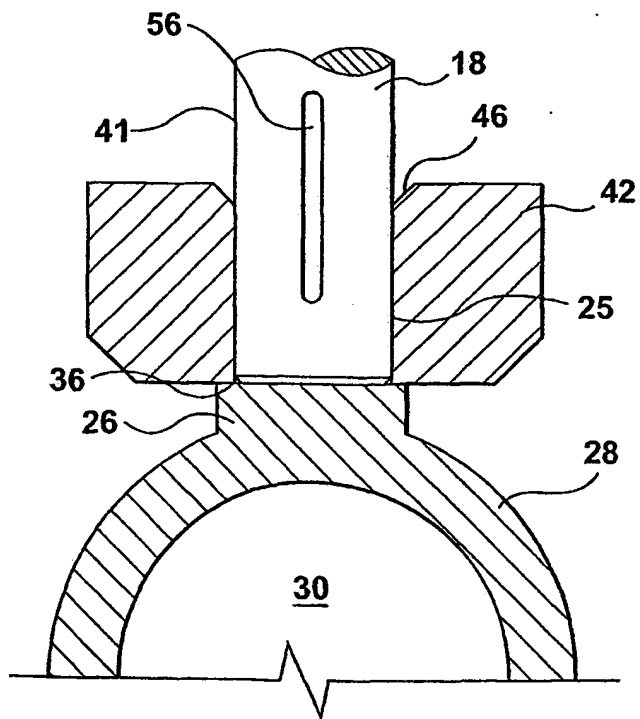


**FIG. 3a**

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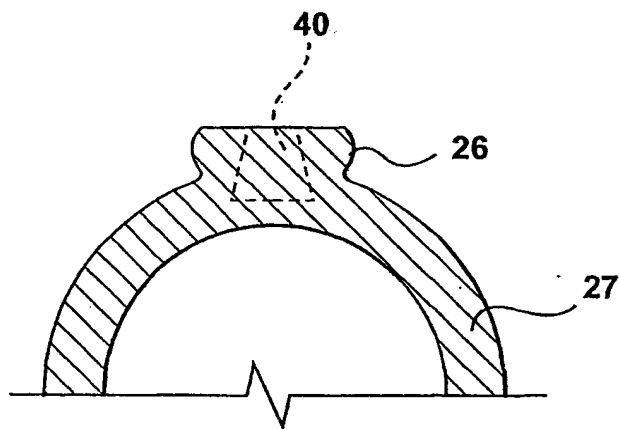


**FIG. 4a**



**FIG. 4b**

5 / 5



**FIG. 5**

## INTERNATIONAL SEARCH REPORT

Intern: Application No

PCT/CA 02/00774

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 7 B29C45/28 B29C45/27

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages                                    | Relevant to claim No.   |
|------------|---|-------------------------|
| A          | US 4 108 956 A (LEE SOO-IL)<br>22 August 1978 (1978-08-22)<br><br>figures 4,6<br>column 6, line 9 - column 6, line 63 | 1-6,<br>10-18,<br>22-29 |
| A          | US 6 149 417 A (MAI ARNOLD ET AL)<br>21 November 2000 (2000-11-21)<br><br>figures 1,4,24C                             | 1-6,<br>13-18,<br>25-29 |
| A          | US 6 135 757 A (JENKO EDWARD J)<br>24 October 2000 (2000-10-24)<br>claim 1; figure 4                                  | 1, 12, 13,<br>25, 35    |

☐ Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

## \* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

5 September 2002

Date of mailing of the international search report

26. 11. 02

Name and mailing address of the ISA

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## INTERNATIONAL SEARCH REPORT

Intern. Application No

PCT/CA 02/00774

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s) | Publication<br>date     |
|---|---------------------|----------------------------|-------------------------|
| US 4108956                                | A                   | 22-08-1978                 | NONE                    |
| US 6149417                                | A                   | 21-11-2000                 | US 6146123 A 14-11-2000 |
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|   |                     | WO 9841378 A1 24-09-1998   |                         |
| US 6135757                                | A                   | 24-10-2000                 | NONE                    |

# INTERNATIONAL SEARCH REPORT

ational application No.  
PCT/CA 02/00774

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:  
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-35

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.



FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-35

Valve gated apparatus for injection molding of articles having a protruding vestige section.

2. Claim : 36

Gate insert